

# NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY



# SCIENCE UPDATE



**NAMRL MISSION: TO CONDUCT RESEARCH, DEVELOPMENT, TEST, AND EVALUATION IN AEROSPACE MEDICINE AND RELATED SCIENCES TO ENHANCE THE HEALTH, SAFETY AND OPERATIONAL READINESS OF NAVY, MARINE CORPS, AND OTHER MILITARY PERSONNEL.**

**SPRING 2010**

## NAMRL HOSTS AIR FORCE 711TH HUMAN PERFORMANCE WING LEADERSHIP

As NAMRL prepares for relocation to Wright-Patterson AFB, OH in FY 2011, the development of collaborative research rela-



**NAMRL and USAF 711th HPW leaders discuss opportunities for research collaboration.**



**NAMRL Biomedical Engineer describes the Visual Vestibular Sphere Device to USAF 711th Human Performance Wing leaders.**

tionships in the Dayton region has become a top laboratory priority. Foremost among the developing relationships are those being forged with NAMRL's Air Force partners in the nascent Center of Excellence for Aeromedical Research. Following a December 2009 NAMRL visit to Dayton, leaders from the Air Force 711th Human Performance Wing visited NAMRL in February 2010 to learn more about the mission and capabilities of the lab, and to discuss opportunities for aeromedical and human performance research collaborations. Visiting Air Force research leaders included: Director, 711th HPW; Vice Director, 711th HPW; Chief Scientist, 711th HPW; Director, Human Effectiveness Directorate; Commander of the USAF School of Aerospace Medicine, and a myriad of other research directors and scientific leaders.

NAMRL's Officer in Charge and acting Scientific Director began the morning with a laboratory overview. NAMRL scientists provided tours of their lab areas and briefings on current research. The meetings were concluded with a round table discussion focusing on opportunities for collaboration, including specific areas of common scientific interest, specifically iden-

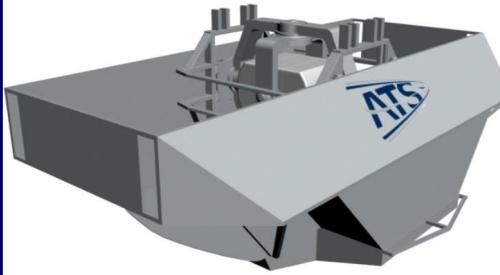
tifying areas where each could rely on, or join with, the other to fill current voids. The day was extremely productive and it began the formalization process of the new joint aeromedical research center. In addition to the development of working relationships with current 711th HPW partners in Dayton, NAMRL leadership has scheduled visits during 2010 to the 711th HPW units in San Antonio, TX, and Mesa, AZ, which also will relocate to Wright-Patterson AFB in 2011.

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## FUTURE STATE-OF-THE-ART RESEARCH AT NAMRL

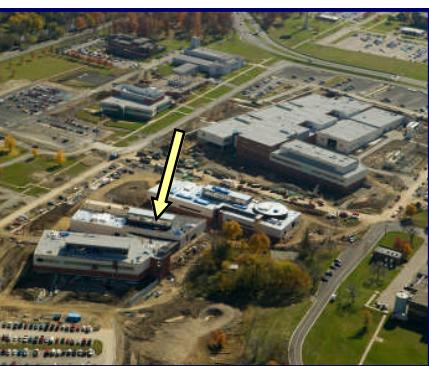
NAMRL's newest research acquisition, the Disorientation Research Device (DRD), will play a significant role in the laboratory's portfolio of projects, as well as the Joint Navy/Air Force, Center of Excellence for Aeromedical Research. The DRD capabilities include the integration of a precisely controlled, dynamically changing acceleration environment providing six independent degrees of freedom with reconfigurable visual displays and data collection capabilities, including physiological monitoring and telemetry; simultaneous yaw, pitch and roll movement; sustained acceleration to 3g; and off-center rotation. The capsule has a total of 32 cubic feet of "payload space," which can accommodate physiologic monitoring equipment to support fatigue, respiratory, and cardiovascular research in unusual acceleration environments. In addition, the payload area is large enough to mount reduced oxygen breathing devices (ROBDs) and associated air tanks, in order to support hypoxia research. Of keen interest is the unique "cockpit" design which allows for man-in-the-loop mode in which the research participant ("pilot") controls



Artist Rendition of the DRD

movements of the device from within the capsule. These controls can be linked with a flight simulator so that the "pilot" is presented with the forces that he/she would feel in the actual flight environment while flying the simulator. The cockpit affords researchers the choice of seating only one subject centered in the capsule or two subjects side to side.

### Future Location of the DRD



Current progress (FEB 2010) of NAMRU-Dayton

## BRAC UPDATE

This BRAC update focuses on the new Disorientation Research Device (DRD) to be installed at Navy Medicine R&D's newest command, Naval Medical Research Unit - Dayton, OH (NAMRU-D). The Environmental Tectonics Corporation (ETC), Philadelphia, PA, was awarded the contract to build the DRD in January 2009. ETC's primary corporate mission is to design, manufacture, and deliver high-fidelity equipment for worldwide aerospace and biomedical industries. ETC is moving ahead with all aspects of design and fabrication of the DRD, as well as ensuring complete integration with the MILCON effort. ETC's approach to design and mode of development is undoubtedly 21<sup>st</sup> century. The company's methodology utilizes dynamic models which incorporate the kinematics of the six axes of motion and account for cross-coupling interactions between multiple axes moving simultaneously. As mentioned in a previous Science Update, having six degrees of freedom provides a research platform that will be capable of running complex multi-axial acceleration research protocols. ETC submitted their Critical Design Review in November 2009 which presents their final design solution to meet all technical and scientific requirements specified by the NAMRL technical team and leadership. ETC has started fabrication of major system components and subcomponents and has scheduled the first stage of installation at Dayton to begin November 2010. ETC's projected timeline is on target for completion of site installation in September 2011.

With a seemingly endless list of capabilities, the Navy's one-of-a-kind research device will undoubtedly be a cornerstone of research in the new Joint Center of Excellence. The device will assist researchers in addressing fleet aeromedical problems that include, but are not limited to, spatial disorientation, cockpit design, motion sickness and associated interventions, and visual and other sensory and acceleration issues. Innumerable collaborative efforts are anticipated as the synergies afforded by the new Center of Excellence become a reality. The matchless capabilities and research resources will be a magnet for research in general, but especially for aeromedical research for the Services.

## NAMRL'S REDUCED OXYGEN BREATHING DEVICE (ROBD)

Hypoxia remains one of the primary physiological threats to Naval Aviators. Naval Safety Center statistics reported three FA-18 Class-A, hypoxia-related mishaps between 2000 and 2006 and during the two



year period 2007-2008, there were 16 reported incidents not resulting in loss of aircraft or personnel. As the Navy's designated aeromedical research laboratory, NAMRL is committed to addressing the threat of hypoxia by advancing our basic understanding of the effects of hypoxia on aviation personnel and applying technologies to mitigate hypoxia's negative impact on aviation safety. NAMRL houses a state-of-the-art hypoxia laboratory anchored by the Reduced Oxygen Breathing Device (ROBD), a technology developed at NAMRL in the 1990s to provide hypoxia awareness training to aviators. The ROBD is capable of delivering gas mixtures with O<sub>2</sub> concentrations equivalent to altitudes ranging from sea-level to 35,000 ft. Unlike altitude chambers, the ROBD delivers hypoxic air mixtures through a standard aviation mask and does not expose subjects to changes in environmental pressure, making it ideal for use in experimental applications. NAMRL investigators are currently working to

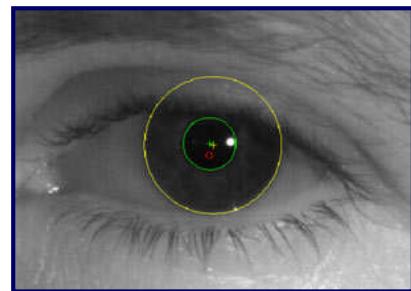
complete a project to test several physiological sensor technologies for their application in an in-cockpit hypoxia detection and early warning system. This spring, NAMRL, in collaboration with the University of Dayton Research Institute, will kick off a project to establish the time required for the human cognitive system to fully recover following a significant hypoxia exposure. The relocation of Naval aeromedical research to the Naval Medical Research Unit - Dayton, OH (NAMRU-D) in 2011 will mark a significant expansion of existing capabilities for the study of hypoxia. NAMRU-D will house a laboratory capable of accommodating six ROBDs, and the Dayton area provides a collaborative scientific environment for aviation research second to none. Among other planned collaborations, NAMRL investigators will partner with researchers at the University of Dayton Research Institute and the Boonshoft Medical School of Wright State University to establish a bench science hypoxia research program. The hypoxia program will seek to advance our understanding of hypoxia's effects on the central nervous system using advanced imaging technologies and modern neuropsychological and neurophysiologic methods.



Reduced Oxygen Breathing Device

## OPERATIONAL STRESS AND RESILIENCE PROGRAM

The Operational Stress and Resilience Program (OSRP) was introduced in 2009, and since then, its interdisciplinary team of military and civilian scientists has taken full advantage of the lab's considerable human and technological resources. Representing a new core capability for NAMRL, OSRP combines state-of-the-science psychological and physiological measurement capabilities with the primary goal of supporting the warfighter in operational applications. In addition to heart rate, stroke volume, cardiac output, endocrine sampling, pupillometry, eye tracking, electrogastrography (EGG), electrocardiography (EKG), blood pressure, and other biometrics, OSRP has acquired and applied the most up-to-date computer-based experiment generation software and voice analysis capabilities. In order to process this complex information, OSRP scientists are completing training in MATLAB, a high-level computer language used for developing algorithms, visualizing data, and analyzing non-linear bio-signals. Another way in which the OSRP's goal of dynamic support for the warfighter is being accomplished is through use of multiple collaborators, including the Naval Health Research Center (NHRC), SERE-West, California State University, Duke University Medical Center, University of California San Diego, Yale University School of Medicine and Harvard University. As NAMRL moves closer toward realignment with Wright-Patterson Air Force Base, the aim of OSRP is to remain adaptive and portable through continued collaboration with government and university labs. This approach to research will enable NAMRL, and the OSRP research team, to maintain continuity of current projects and extend the capability to answer future needs of the fleet.



## CDR'S CORNER



Henry Ford once said, "Coming together is a beginning. Keeping together is progress. Working together is success". These words are particularly relevant for the complex nature of aeromedical science, where many issues are best solved with collaboration, so that goals that may otherwise be unattainable become reality. NAMRL has a rich history of collaboration with other laboratories and institutions, including: the National Aeronautical and Space Administration (NASA), Naval Aviation Systems Command (NAVAIR), the U. S. Army Aeromedical Research Laboratory (USAARL), the Naval Operational Medicine Institute (NOMI), and a multitude of universities and industry. These partnerships have allowed incredible advancements and product delivery in Biomedical, Human Performance, Aerospace, Acceleration, and Sensory Sciences. As NAMRL progresses toward Realignment with Wright Patterson Air Force Base (WPAFB) in Dayton, OH, senior scientists and our NMR&D Fleet Liaison for Aviation continue to build upon our model of joint programs and the synergistic approach in conducting research. Current Dayton-based collaborators include the University of Dayton Research Institute (UDRI) for a study involving physiological and cognitive function and recovery from acute hypoxia, with future work capitalizing on research combining hypoxia and cutting-edge brain imaging and mapping. We are also in the process of creating other academic relationships with the University of Dayton and Wright State University to enable expansion of current and future research programs. When the Base Realignment and Closure is concluded, a new Aerospace Medicine Center of Excellence for Research, Training, and Education will be established. This "campus", and the combined staffs and research instruments, may represent one of the most extraordinary examples of collaboration and relationship building in NAMRL's history and in the Navy Medicine R&D enterprise. The state-of-the-art Disorientation Research Device, Vertical Linear Accelerator, and Visual Vestibular Sphere Device will undoubtedly be main attractions at the Center of Excellence, allowing Navy researchers and collaborators unprecedented flexibility in designing human performance protocols and performing biomedical research. The Air Force Human Performance Wing will provide a high-G centrifuge with fully configurable cockpit, hypobaric chambers, and high-fidelity flight simulators. In addition, the variety of laboratories meeting under one roof will supply a powerhouse of individuals with the knowledge, skills, and abilities to ensure world class research aimed at enhancing the health, safety, and operational readiness of our DoD forces. If Henry Ford is correct, Navy Medicine's Aeromedical Research Program is exceptionally poised for success, today and in the future.

## NAMRL, NAMI SCIENTISTS DEVELOP PERFORMANCE BASED MEASURE SCORING ALGORITHM

Naval pilot and flight officer training is an expensive enterprise, costing the Navy over \$1 million per trainee. Candidates who do not complete flight training represent significant financial and resource loss on that investment. In an attempt to avoid undue student attrition, and maximize return on training investment, the Navy currently employs the Aviation Selection Test Battery (ASTB), a paper and pencil based evaluation, to select Naval aviation candidates. The ASTB successfully predicts flight candidate performance on academic phases of flight school, but falls short when it comes to predicting performance in early phases of flight training. To address this shortfall, the Operational Psychology De-

partment of the Naval Aerospace Medical Institute (NAMI) has designed the Performance Based Measure (PBM), a test of psychomotor and spatial abilities that closely mimic operational pilot skills. NAMRL was recently funded by the Office of Naval Research's Capable Manpower Future Naval Capability program to develop a psychometrically sound scoring algorithm for the PBM to maximize its applicability to Naval flight student selection. The result, reached in partnership with the Drasgow Consulting Group, was successfully transitioned to NAMI in November and will be integrated into the Naval aviation selection system for use as early as April 2010. Evidence suggests that the integration of the PBM with the NAMRL and NAMI

developed scoring algorithm into the Navy's current selection system will double the ability of the ASTB to predict non-academic portions of flight school performance. This improved capability will optimize flight candidate performance in flight school and potentially save the Navy millions through the reduction of student attrition.



**Naval Aerospace Medical Research Laboratory**

[www.med.navy.mil/sites/nhrc/namrl](http://www.med.navy.mil/sites/nhrc/namrl)